DOCUMENT RESUME

ED 236 542 CS 007 280

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TITLE Teaching Comprehension. (Application of the Model by Dr. M. Hunt.)
PUB DATE Aug 83
NOTE 23p.; Paper presented at the Annual Meeting of the Rocky Mountain Regional Conference of the International Reading Association (Billings, MT, October 7-9, 1982). For the model, see CS 007 279.
PUB TYPE Speeches/Conference Papers (150) -- Information Analyses (070)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Processes; Content Area Reading; *Critical Thinking; Elementary Education; Models; *Questioning Techniques; *Reading Comprehension; *Schemata (Cognition); Teaching Methods
IDENTIFIERS *Synaptic Linking Process

ABSTRACT

Through instruction in synaptic linking--the process of relating ideas and information to produce expanded interpretations and new constructs--teachers provide students with a model for answering higher level questions about their reading material. Presenting a carefully planned sequence of reading comprehension questions that require skills ranging from simple recall to evaluation, teachers establish an interplay between creative top-down and skill based bottom-up processing and lead students to make mental associations using their imagination and the critical/creative reading processes. By giving students practice with writing, problem solving, doing anagrams, and text mapping, and by encouraging their participation in Junior Great Books--a program fostering individual interpretive thinking through a process of shared group inquiry--teachers can encourage students' independent use of the synaptic linking process. Teachers can also improve students' reading comprehension by increasing their fluency with exercises in oral reading, vocabulary development, and independent reading. Finally, teachers can use content in other subject areas to both strengthen reading comprehension and stimulate synaptic linking. (Contains a scope and sequence chart for reading in biological science.) (MM)

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TEACHING COMPREHENSION

(Application of the Model by Dr. M. Hunt)

by

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(Doctorate In-Process)

August 1983

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TEACHING COMPREHENSION

Introduction:

You have just read a theoretical position which postulates reading comprehension as a complex thinking process characterized by "bracketing" chunks of information and chaining or linking related brackets to form new comprehension constructs.

This paper will reiterate the key theoretical points and propose a practical application to the classroom. The material presented here is based on fourteen years of work in education including teaching at all elementary grade levels in Alaska, California and Montana, as well as reading specialist work with students in grades K-6. The author is currently an elementary school principal in Libby, Montana.

* * * * *

I am comfortable with the educational job we have done in word decoding with students, but have long been distressed by the shallow comprehension abilities of many students in our nation. There is no easy answer to the problem, but I believe that the first step lies in increasing teacher understanding of comprehension processes so that they can suggest and develop teaching techniques based on awareness.
A student must have a reliable sound/symbol decoding strategy. But a mistake which can easily be made is that the reading text becomes a mindless vehicle. Is the teacher controlling the text, or does the text control the teacher? The lesson is scripted--the teacher reads the script--the students respond with the "right" answer. Students become proficient at guessing which answer the teacher wants to hear. Do basal comprehension questions <u>teach</u>, or merely <u>test</u> reading comprehension? I, and some other researchers, submit that they merely test; for there is little or no instruction, only affirmation or correction of the student response (Jenkins and Pany, 1980).

A study conducted by Dolores Durkin observed twenty-four, fourth grade teachers for 5000 minutes total during reading instruction (200 minutes per teacher). It was found that instruction in reading comprehension occurred <u>less</u> than 1% of the time (Durkin, 1978-79).

This author doesn't fault the teachers. They have little time to discover the critical questions in reading comprehension. Teachers rely on the basal programs developed by publishers. It is up to the curriculum researchers to ask the questions and stimulate discovery of the answers. An important question may be "Does instruction in disparate comprehension skills, such as'locating the answer' and 'finding the details' really do the job in teaching reading comprehension? Or do students need to be taught a strategy to help them tie related textual ideas together as a unifying element in comprehension instruction?" This strategy would involve stimulation of the active thought processes which are so crucial to reading comprehension. These thought processes begin at birth and require nurturing along with the development of specific reading skills such as the ability to decode, which is a precursor of reading fluency and comprehension.

A Comprehension Strategy:

Let me digress for a moment and review the essence of comprehension as Dr. Hunt and I perceive it:

A person (child or adult) brackets pieces, or "chunks" of life experiences in the mind. What is bracketed has personal relevance or meaning. The bracketed material may be related to past bracketed material; or it may be bracketed as intuitively important--though it may lack meaning at the time. Let me give you an example:

A gentleman once told me that when he was eight years old, and his sister was seventeen, he overheard his mother tell her in a very serious tone, "If you are ever in trouble, your father and I want you to know you can turn to us for help." The boy's sister looked uncomfortable, but responded that she understood. The boy was puzzled and said to his mother, "Why did you say that to her? Did she do something wrong?" The mother responded, "No--don't worry. Your sister understands." Nine years later the boy got into serious difficulty and was greatly

distressed. The words his mother had spoken when he was a young boy flashed to mind- but they suddenly had new meaning. The boy asked for, and received, his parents' help. What had been bracketed as intuitively important was brought forth with true meaning when it was needed.

Bracketed material may appear to stand alone, but more often it will be "chained" or "linked" to other bracketed material to form a schemata or mental construct which will provide for comprehension of a situation. All of our knowledge in the brain is embedded in neurons (nerve cells) and their connections. Between the neurons is a space of less than a millionth of an inch called the synapse. Messages are relayed from one neuron to another by chemicals called neuro-transmitters which are stimulated by impulses to move across the synaptic gap. Because bracketed material cannot be linked without neural stimulation across the brain synapses, I refer to the mental chaining process as "Synaptic Linking." A plan then, for reading comprehension, is to begin by <u>teaching</u> a child how to perform mental chaining, which will enable him to extend and engineer situational comprehension through his own creative and personal synaptic linking.

To contrast this plan, one can observe the basal testing (often confused with teaching) of reading comprehension. Following story reading, a series of questions are asked. The questions are unrelated one to the other. The questions are at different cognitive levels, such as interpretive and evaluative as well as literal, which is an improvement in reading instruction. But the questioning has no strategy for developing synaptic links between textual ideas or points. Therefore the questions test comprehension, but do not teach comprehension.

<u>Synaptic Linking</u>:

What is Synaptic Linking? It is the mental process of chaining and relating ideas and information so that interpretations may be expanded and new constructs can emerge.

What is the rationale for instruction in Synaptic Linking? Research has shown that most of the questioning that takes place in classrooms is at the lower levels of thinking. A research review by Robert Stevens and Barak Rosenshine (University of Illinois) titled "Advances in Research on Teaching" outlined two well-designed experimental studies (Gall et al., 1975; and the Stanford Program on Teacher Effectiveness, 1976) which found that asking higher level cognitive questions had no measurable effect on performance on follow-up tests utilizing higher level questions. Stevens and Rosenshine state that a problem with both high level questions and reading comprehension questions is that there is no demonstration phase--"students are not provided with a general paradigm...for answering, and the reason that demonstration has received so little attention is probably that (reading comprehension) is so difficult to conceptualize, let alone model or demonstrate." (Barak and Rosenshine, 1981)

It is difficult for students to answer a higher level question because they have not received instruction in chaining ideas cognitively, a process at the base of complex levels of thinking. Synaptic linking can teach students this process, and encourages teachers to formulate questions based on all of the various levels of a taxonomy of thought. The structured procedures teach students how to link ideas <u>within</u> textual material in order to answer higher level interpretive questions.

The goal of synaptic linking is to make a student aware of the procedure so that he/she will eventually make a conscious application to <u>out of text</u> as well as within text situations. In essence, an application of critical and creative thinking to life situations and problems.

The teacher will need to plan the questioning sequence so that questions relate to each other. The questioning strategy will fluctuate from lower to higher cognitive levels with the goal being stimulation of synaptic links so that a student will have progressed through mental associations in order to answer a final related question.

Though this strategy has not been tested a great deal, the initial tries with students, which have been included in this paper, have been highly successful. Teachers are encouraged to send the author their results and comments as they apply the strategy with their own students.

Instructional Procedures for Synaptic Linking

1. Decide on a final overall question requiring higher levels of interpretive thought. To decide on the question it is helpful to identify the main writing techniques, theme, or developmental strands used by the author. Does he build a strong characterization, for example? Or does he use strong clues throughout a story to help reinforce a certain story development? For examples of the final interpretive questions, please see the last questions on pages 7-11 following.

2. Beginning with a simple question using a verb from the lower level of Bloom's Taxonomy (See page 11), build questions so that students will be guided logically through the text, making cognitive links in order to have a comprehension framework for answering the final interpretive question. The teacher will need to analyze the story content, making the necessary mental links with related textual material in order to develop the questions to help students make the proper links.

   Often questions will follow a "chunking" or tandem pattern of low to high, such as Identify...(low knowledge level of Bloom's Taxonomy), to Support... (high evaluation level of Taxonomy).

   To teach the synaptic linking process the instructor needs to have a thorough familiarity with the story under discussion. He/She must also be able to project the questioning path for arriving at an answer to the final question. But perhaps most acutely, and interestingly, the instructor needs to have the flexibility to utilize new and unexpected student answers which may or may not be legitimate. If answers are not legitimate the student needs to be shown why. The answers are not used in the linking but have become a part of the teaching-learning situation, because students can learn from understanding their errors. If answers are legitimate but did not previously occur to the instructor, they should be incorporated into the synaptic linking process. The goal is creative and reasonable chaining--it has to be recognized and nurtured.

3. As the discussion proceeds, illustrate on the blackboard the synaptic linking process to assist students in understanding what is taking place, and to help them refer back to past stated ideas when answering questions.

On the following page are some points to keep in mind when utilizing this process. This author has not yet decided whether it is best to tell students the final question prior to the discussion, or to let the answer and question evolve through the discussion. More sessions using the procedures will define the most effective method.

Keep in mind:

A) Wait time--students need time to think;

B) Accept all answers. Erase those which students negate because they cannot be supported, either through literal story content or through logical interpretation of content;

C) After one support statement is given for a question (unless the support statements are critical to interpretation) page numbers only may be listed for additional support statements.

D) Encourage all students to participate in the discussion.

E) You may feel some frustration because the process is quite restricting in its narrow discussion focus. But remember that the goal is to teach a child visually as well as aurally how to cognitively link within text material so that he/she will eventually apply the process **independently.**

** A fascinating piece of theoretical information emerged separately in Dr. Hunt's as well as this author's work:

Dr. Hunt proposes that reading comprehension is facilitated by the interplay between the creative top down and the developmental skills, bottom up processing. This author discovered that the reading comprehension process is facilitated when questions are structured so that there is an oscillation between lower cognitive levels (bottom up), and higher cognitive levels (top down) [See Bloom's Taxonomy,p.11]. In essence the findings provide cross validation. Is it also possible that these findings lend support to researchers who argue that the artistic creative processes facilitate academic learning?

The following four pages provide examples of the questions asked as well as the board illustration which is undertaken in the Synaptic Linking process. Please note the final high level question, as well as the related questions and answers which path their way to the final question.

EXAMPLE

Text: Literature and Life
Scott Foresman Co., c. 1979

Story: Flowers for Algernon

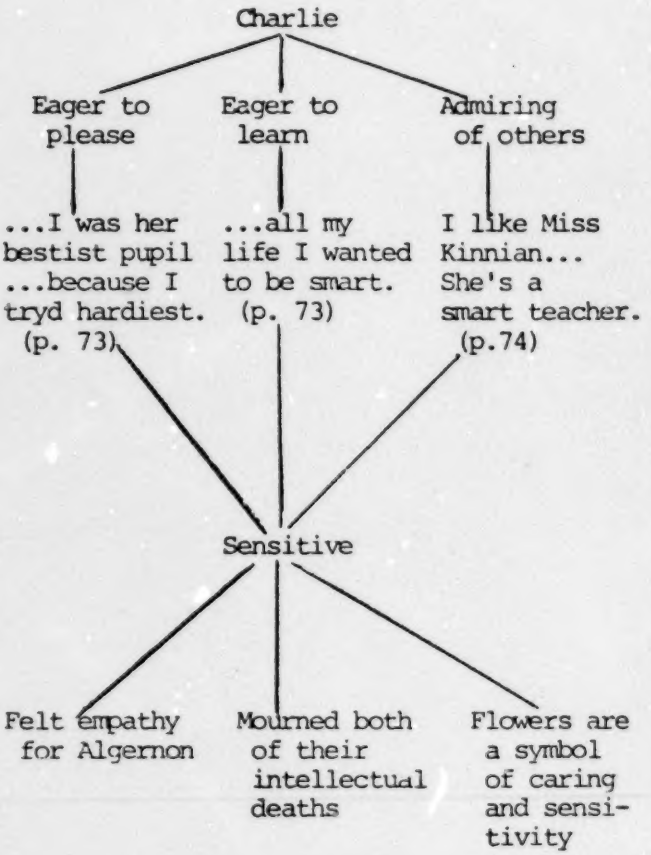
Knowledge: 1. Identify some of Charlie's outstanding characteristics.

Evaluation: 2. Support your choice of characteristics with statements from the story.

Analysis: 3. Based upon the linking so far, would you say that Charlie is a sensitive, or an insensitive person?

Evaluation: *4. Interpret the author's choice of title, Flowers for Algernon, relating it to Charlie's characteristic of "sensitivity".

SYNAPTIC LINKING


Charlie
Eager to please
Eager to learn
Admiring of others
...I was her bestist pupil ...because I tryd hardiest. (p. 73)
...all my life I wanted to be smart. (p. 73)
I like Miss Kinnian... She's a smart teacher. (p.74)
Sensitive
Felt empathy for Algernon
Mourned both of their intellectual deaths
Flowers are a symbol of caring and sensitivity

Pages 7-10 of this handout provide examples of the Synaptic Linking process. On the left are the teacher's questions developed from the various levels of Bloom's Taxonomy. On the right is the board illustration, to show students how the answers to the related questions can be chained or "linked" to provide the information needed to answer the final question.

This author has found difficulty in applying the above process to basal reader stories. They seem to lack the interpretive depth needed to make meaningful links.

EXAMPLE

Story: A Christmas Carol
by Charles Dickens

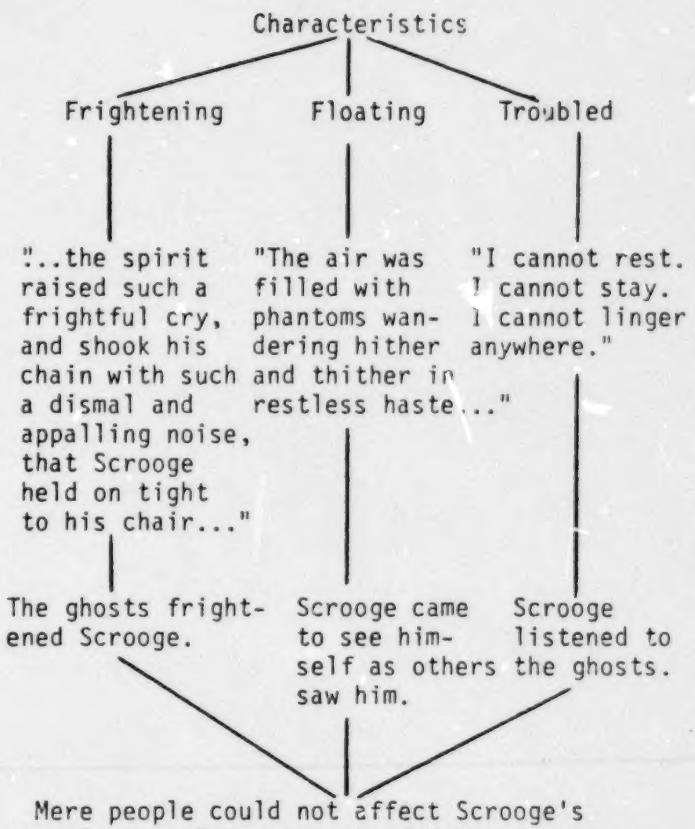
Comprehension: 1. List some of the characteristics of Marley's "Ghost" in this story.

Evaluation: 2. Relate examples from the story to the characteristics of "frightening", "floating" and "troubled".

Synthesis: 3. Summarize the ghosts' impact on Scrooge.

Evaluation: *4. Based on the linking, why does the author choose ghosts, rather than people, to assist Scrooge in changing his attitude and behavior?

SYNAPTIC LINKING


Characteristics
Frightening
Floating
Troubled
"..the spirit raised such a frightful cry, and shook his chain with such a dismal and appalling noise, that Scrooge held on tight to his chair..."
"The air was filled with phantoms wandering hither and thither in restless haste..."
"I cannot rest. I cannot stay. I cannot linger anywhere."
The ghosts frightened Scrooge.
Scrooge came to see himself as others saw him.
Scrooge listened to the ghosts.

Mere people could not affect Scrooge's outlook on life; but the frightening view of the ghosts, who had the ability to travel to the past and the future to show Scrooge his ways, caused him to listen and change.

"A Christmas Carol"
From the Junior Great Books
Series 5, volume 2
The Great Books Foundation
c. 1975

Mrs. Raenelle Lees, a teacher in Missoula, Montana, applied the Synaptic Linking process to a story by Ray Bradbury called, "Marionettes, Inc.", with successful results:

Comprehension: 1. Describe how Smith felt about his marriage.

Evaluation: 2. Support your descriptions with statements from the story.

Comprehension: 3. Identify the emotions that Smith experienced when he found out about the existence of Marionettes, Inc.

Evaluation: 4. Support your choice of emotions with statements from the story.

Comprehension: 5. Identify the emotions that Smith experienced when he came home and saw Nettie sleeping.

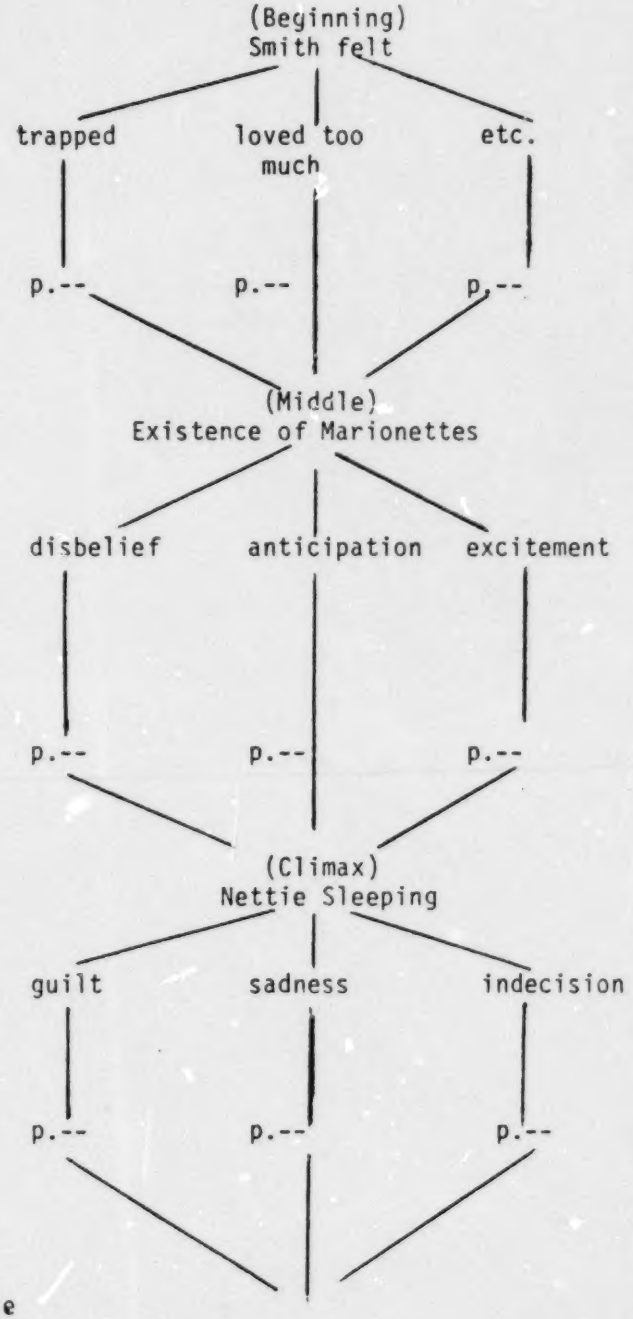
Evaluation: 6. Support your choice of emotions with statements from the story.

Comprehension: 7. Identify the emotions that Smith experienced when he discovered Nettie had tricked him. (horror, terror, loneliness)

Evaluation: 8. Support with statements.

Evaluation: *9. Compare Smith's character at the beginning and end relating to the variety of emotions experienced.

SYNAPTIC LINKING



Story: The Fifty-First Dragon
by Heywood Broun

Comprehension: 1. Give examples of times in the story when the Headmaster raised Gawaine's self-confidence.

Evaluation: 2. Relate the examples above to their effects on Gawaine.

Comprehension: 3. What was the effect on Gawaine when he forgot the magic word?

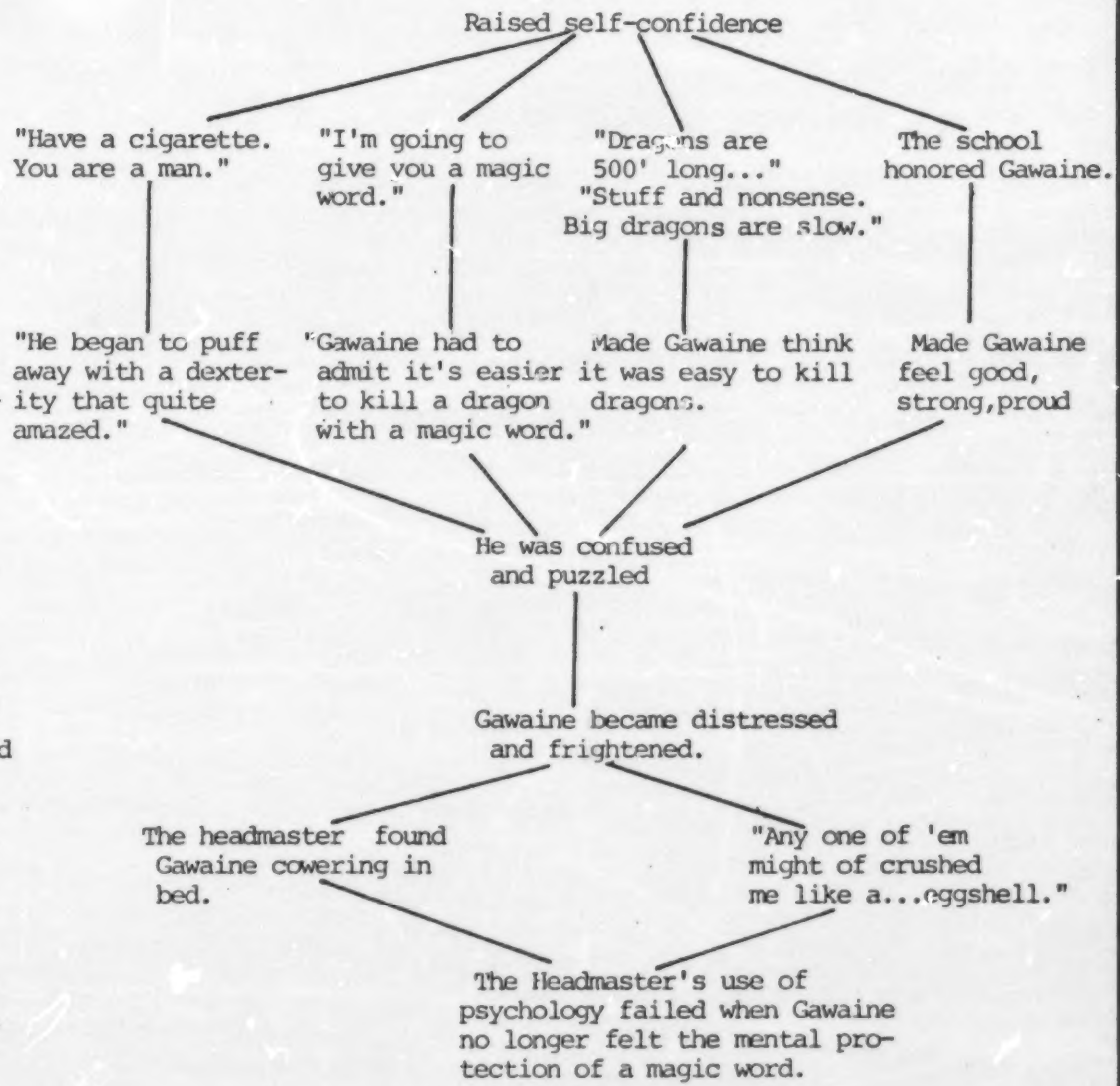
Evaluation: 4. Describe the effect of the Headmaster's explanation to Gawaine as to why the magic word was useless.

Comprehension: 5. Give examples to show that Gawaine had become frightened.

Synthesis: *6. Explain why the Headmaster's plan to make Gawaine a model knight failed.

"The Fifty-First Dragon"
From the Junior Great Books
Series 5 , volume 2
The Great Books Foundation
c. 1975

SYNAPTIC LINKING


Raised self-confidence
"Have a cigarette. You are a man."
"I'm going to give you a magic word."
"Dragons are 500' long..."
"Stuff and nonsense. Big dragons are slow."
The school honored Gawaine.
"He began to puff away with a dexterity that quite amazed."
"Gawaine had to admit it's easier to kill a dragon with a magic word."
Made Gawaine think it was easy to kill dragons.
Made Gawaine feel good, strong, proud
He was confused and puzzled
Gawaine became distressed and frightened.
The headmaster found Gawaine cowering in bed.
"Any one of 'em might of crushed me like a...eggshell."
The Headmaster's use of psychology failed when Gawaine no longer felt the mental protection of a magic word.

A RELATION OF VERBS AND TAXONOMIES

Verbs for Question (Bloom)	Bloom's Taxonomy	Guilford (juxtaposed at upper levels)	Taba	Levels of Thinking
Compose, create, devise, design, generate, plan, modify		Divergent Production	Cognitive Task III	Creative Thinking Level
Appraise, compare, conclude, contrast, criticize, describe, justify, interpret, relate, summarize, report	Evaluation	Evaluation		Critical Thinking Level
Categorize, combine, compile, explain, organize, rearrange, relate, summarize, revise, reconstruct, reorganize	Synthesis	Convergent Production	Cognitive Task II	Interpretive Thinking Level
Break down, diagram, differentiate, discriminate, distinguish, identify, illustrate, infer, outline, select	Analysis	Cognition		
Change, compute, demonstrate, discover, notify, predict, prepare, produce, show, solve	Application			
Who, what, where, when, list, match, recall, define, describe, identify, label, name, state, outline	Comprehension		Cognitive Task I	Literal Thinking Level
	Knowledge	Memory		

Presented here is this author's interpretation of a possible relationship between the cognitive taxonomies of Bloom, Guilford and Taba, plus some comparable levels of thinking. (Bloom, 1956; Guilford, 1967; Taba, 1962).

The evaluation level in Guilford's Model was juxtaposed to conform to the evaluation level of Bloom. However, dotted lines indicate overlap and movement between the upper three levels in the Guilford Model. Creative process verbs were pulled from the synthesis level of Bloom to form a Creative thought level.

It is important to emphasize at this point that instruction in Synaptic Linking is only a tool to be used until the students demonstrate ability to make creative synaptic links independently. The teaching technique is structured and pre-planned. EXPECTED STUDENT RESPONSES ARE PROJECTED AHEAD OF TIME, BUT THE TEACHER MUST BE FLEXIBLE ENOUGH TO ENGINEER SYNAPTIC LINKS WITH THE GIVEN STUDENT RESPONSES DURING THE LESSON. If students give answers which don't lend themselves to linking, the teacher will need to probe further with questioning. This technique is visualized as being most appropriate for grades 4-12 because of the greater complexity of the literary materials, but the idea of synaptic linking in a verbal mode can be modified to work with even the youngest child. I read my 6 year old son a story in which a man was stuck up to his neck in a hollow log filled with honey. As we looked at the picture my son said, "That man is stuck in quicksand." I pointed out that there were bees over the man's head. Then he said with glee,"It's honey!" Two days later I asked my son if he remembered what the man was stuck in. He replied, "quicksand". I said simply "Bees", and he said "Honey". He had made the link.

All first grade teachers know how difficult it is to help students to remember the sight word "here". It is abstract and cannot be decoded. A trick is to help the child make a synaptic link by relating the abstract word to a concrete object. When I taught first grade I would make a large dog on butcher paper with a balloon from his mouth with the words "Here, here, here, here..." printed inside. I told my students, "My dog has a sore throat and can only bark"Here, here, here, here..." no matter how hard he tries." The students then bark, "Here, here, here here" with my dog. We would do this for two or three days. As the students came to the word "here" in their reading texts the first day, I would say, "What does my dog bark?" Then on the second day, "Dog bark?" And on the third day, "Dog?" Each time they would remember the associational word "Here". Pavlov would have loved us!

Synaptic instruction through textual prose is a vehicle leading children to the goal of multi-media/multi-sensory, non-context bound levels of chaining, where they make mental associations utilizing their imagination, and the critical/creative reading processes. The student, eventually, would personally interact with the reading passage and make the necessary links at the highest creative levels, forming and testing his hypotheses of reality, and the "goodness of fit" against the intentions of the author.

The Creative Reader:

Torrance, in his book Gifted Children in the Classroom, talks of the creative reader as one who...

> makes himself aware of the gaps in knowledge, the unsolved problems, the missing elements, and things that are incomplete or out of focus. He sees new relationships, creates new combinations, synthesizes relatively unrelated elements into a coherent whole, redefines or transforms certain pieces of information to discover new uses, and builds onto what is known.

The creative reader is the educational paragon. He has internalized the association and linking processes. He does not need to be coached in making mental links with bracketed material--he does this automatically. To eliminate the creative cognitive processes suppresses comprehension and learning to a narrow mastery of disparate skills. Encouragement of the creative process fosters a learning style that is dynamic and oscillating. Learning and comprehension proceed from the top down as well as from the bottom up. "They are driven by pre-existing concepts as well as by data from the text." As an illustration Dr. Hunt and I were separately asked the following riddle:

> The man who made it didn't want it;
> The man who bought it didn't use it;
> The man who used it couldn't see it.
> What was it?

Dr. Hunt and I each guessed the correct answer after one question because we made personal mental links using pre-existing concepts as well as the data from the riddle.

I asked the following question: "Was the man who used it blind?" Answer:"No"
Dr. Hunt's question: "Was the object consumable?" Answer: "No"
My reasoning was that if the man was not blind he must have been dead. An object he could not see would be his coffin.
Dr. Hunt's reasoning was if the object was not consumable it had to be beyond this world. Hence, an other-worldly object associated with a man who could not see it--a coffin. We infer from what is directly stated, things which are implied. We make up more than is there in order to fill in the "gaps".

Hierarchical - Horizontal - Heterarchical:

Research has shown that the major comprehension skills in most basal programs are introduced in the first grade (for example,Noting Details) (Rosenshine, 1980). The same skills with the addition of some unique skills, are re-taught year after year in an increasingly difficult context. So we can conceptualize the major skills of reading comprehension as being horizontally funnel-shaped, rather than hierarchical.

Dr. Hunt previously defined heterarchical as the top-down, creative processing ability. Heterarchical processing makes teaching more complex. Teachers may feel a loss of dominance in the teaching-learning situation. Also, it may become impossible to assign a "letter grade" to the student's answer. For these reasons most tests consist of Knowledge level, definitive responses. Learning is compartmentalized into small bits of fact. Certainly there are instructional sequences which call for specific answers. And facts are important in developing a general fund of personal knowledge. But a charge to teachers is that every day also have periods of instruction using questioning strategies which will help students apply heterarchical, creative processing, through synaptic linking, to the basic comprehension skills which are expanded year after year.

We have to provide students with a general fund of information, realizing that many "facts" will be out-dated or obsolete by the time the student reaches adulthood. To extend thought processes there should be as many opportunities as possible for students to employ the synaptic linking process. This can be accomplished by:

1. encouraging a great deal of writing as well as reading;
2. problem solving with students (such as the "coffin" example)-or any practical problem solving;
3. providing students with anagrams to solve;
4. teaching students how to do text mapping or webbing (Can students map meaning into their own conceptual structures?);
5. teaching students how to make cognitive links in the manner outlined earlier (Synaptic Linking);
6. using a literature program such as the Junior Great Books--a program which fosters individual interpretive thinking through a process of shared group inquiry.

The Comprehension Goal:

We need to ask ourselves, "What is the ultimate purpose of all forms of comprehension instruction?" The answer, creative and high level mental processing, is germane to the salvation of mankind. For only by creative, high level processing will man survive. Does it really matter if a child can name the major rivers of Europe? Or is it more important to comprehend such things as the implications of the conflicts stemming from cultural diversity? Or the significance of the scrambling competition for shrinking natural resources on this earth? To learn the rivers, rote memorization of a chunk of information is required; to comprehend the latter problems, bracketed knowledge must be synaptically linked and re-worked to provide deep understanding. This depth and breadth of thought should be our goal.

Reading Fluency and Comprehension:

What else can educators do to increase reading comprehension? Dr. Hunt mentioned that demarcating phrasal boundaries, or utilizing proper phrasing, can enhance a student's comprehension. How can we assist the student in this area?

One method suggested is that of "Neurological Impress". For those of you who are unfamiliar with this procedure it operates as follows:
The teacher sits to the side of the student and slightly back, so that he or she is talking into the student's ear range. The teacher and student read together orally. At first the teacher's voice leads slightly to provide a model for phrasing and fluency. The teacher must pace according to the student's ability. As the student exhibits greater confidence and fluency, the teacher's voice drops back so that the student is taking the lead. Though the neurological impress method may be helpful, I believe there is a more important goal in assisting students to demarcate phrasal boundaries. That is to help them become "fluent readers." Fluent readers rapidly identify known words; and quickly figure out new words from sound, sense, and structure clues.

- They have an adequate reading sight vocabulary;
- an adequate experiential vocabulary (i.e., an adequate socio-cultural background);
- adequate word analysis abilities;
- smooth sound blending abilities; and
- an adequate eye-voice span (i.e., their eye takes in words ahead of the voice).

Though it is possible to read fluently and lack comprehension, it is not possible to comprehend well when one lacks fluency. Processing capacity is the least yielding when task demands are the highest. Therefore comprehension suffers if a student is disfluent and is struggling with decoding and vocabulary. To develop reading fluency, teachers must help students:

- develop decoding abilities;
- increase vocabulary knowledge (Research states that vocabulary is the single most important predictor of a child's ability to comprehend written material. Adams, 1980)
- increase instant sight word recognition through flash cards and reading practice. Another method to increase sight word recognition of the reading vocabulary is to duplicate original half-page stories made by the teacher at grades 1 and 2, which utilizes the vocabulary from the reading text lesson. The student can read the story to his parents and illustrate the bottom half.
- encourage extensive reading practice at the student's independent, or non-assisted level.
- utilize the technique of Readers' Theatre, where students portray characters in hand held scripts through the medium of their voices.

Comprehension and the Content Areas:

Why are students able to comprehend prose selections more easily than the material found in the subject areas such as Science and Social Studies? Answers to this question are numerous. Thematically important elements in a text tend to be recalled best. In the Addison-Wesley Reading Program, for example, each of the first three grade levels is developed around a different theme. In grade one, the theme is the "Superkids --12 kids and a dog named "Golly". Students relate to the theme and remember the story elements more easily than they would if each story were unrelated. The heavier concept loads in the academic subject areas increase the task demands, and decrease the processing capacity. When students move from simple sentences to higher levels of complexity in text--when they are 'reading to learn,' rather than 'learning to read', as Dr. Hunt mentioned--they may not be able to formulate a syntactic structure which can be chained and later bracketed; and what is worse they may not even know that they aren't able to do it. Consider this typical example from the grade 5 text, SCIENCE, UNDERSTANDING YOUR ENVIRONMENT, (Silver Burdett, c. 1975):

> The star nearest to the earth and the sun is 26 million million miles away... Astronomers, men who study space, use larger units of distance than a mile. One of these units is the light year. A LIGHT YEAR is the distance light travels in 12 months, or 1 year. Light travels about 186,000 miles in 1 second. How many miles are there in a light year? The distance to the star nearest the earth is a little more than $\frac{1}{100,000}$ light years. That star, of course, is the sun.

The vocabulary and concept load of the previous paragraph make mental processing more difficult, but some other Science programs make processing virtually impossible. You can see from the example following that besides having an extremely heavy concept load,which students are expected to know for the unit tests, often the concepts are presented only one time in the first eight grades. The company says they have a "modified Spiral" curriculum approach. Needless to say, in the school district utilizing this program, the children have open book unit tests. Our academic subject areas, such as Science and Social Studies, appear to have a content that must be mastered. Our task then, will be to figure out a way to use that content in creative ways to stimulate synaptic linking and mental processing, so that the greater goal of creative thinking is achieved. For example, you might give your students who are studying North America the following assignment: "With this blank map of the North American continent, design new geographic boundaries for the countries; and then explain why your new geographic boundaries are better than the current ones." Top-down, high level creative processing, that is directly related to bottom-up academic skill learning is a powerful combination and should be utilized to a far greater extent in instruction.

A Review:

To summarize, this presentation reiterated the key theoretical points made by Dr. Hunt, and proposed a plan for teaching students how to synaptically link context bound prose material to answer a high level interpretive question. The point was made that the instruction in mental chaining would be used only until students had internalized the process and demonstrated their ability to be critical/creative readers.

Other methods for increasing a student's synaptic linking abilities were given, such as problem solving; and the importance of reading fluency to comprehension was detailed. Finally, the problem of comprehension in the academic subject areas was posed as a challenge to teachers to develop creative instructional techniques which would achieve greater understanding and thought processing.

* Indicates the grade level at which the specific processes and concepts related to the general objectives are taught

*# Specific objectives reinforced adequately

Objectives only mentioned

SCOPE AND SEQUENCE

I= Introduced
R= Reinforced
E= Expanded
P= Presented

} Relates to General Instructional Objectives and grade levels.

BIOLOGICAL SCIENCE	K	1	2	3	4	5	6	7	8
A. Recognize characteristics and needs of animals	I	R	E	E	E	E			
1. Compare domestic and farm animals.		*							
2. Compare domestic and wild animals.	*	*							
3. Observe and describe similarities and differences.		*							
4. Describe the care required for domestic animals.	*#	*							
5. Classify into animals and non-animals.			*						
6. Infer which animals are older			*						
7. Identify which animals are older.			*						
8. Identify young animals which look like their parents.	*		*						
9. Predict how young animals will change as they grow.			*						
10. Explain the kind of care young animals need.	*		*						
11. Identify the various stages of development in the life cycle of a specific animal.			*					*#	
12. Identify animals as plant eaters (herbivores), meat eaters (carnivores), or plant and meat eaters (omnivores).				*				*#	
13. Match the terminology with its definition: Habitat, predator, prey, food chain.				*	*#			*#	
14. Relate animal adaptations to specific habitats.				*	*#			*#	
15. Identify endangered species and methods of protection.				*	#	*#	*#		
16. Illustrate the interrelationships of plants and animals in food chains.				*			*#	*#	
17. Give examples of animals with adaptations for survival.					*	*#			
18. List the advantages and disadvantages of various adaptations.					*				
19. Identify body parts and coverings that are adaptations for survival.					*				

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